

8100-2-18



U.S. Department
of Transportation

Federal Aviation
Administration

Memorandum

Subject: **INFORMATION: Clarification of Intent**
14 CFR part 23, Fatigue Evaluation
(§§ 23.571 through 23.575) — Landing Gear

Date: JUN 3 1998

From: Manager, Small Airplane Directorate
Aircraft Certification Office, ACE-100

Reply to
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To: Managers, All Aircraft Certification Offices

During a Designated Engineering Representative (DER) conference in Chicago (May 1998), a DER asked the FAA representative if the fatigue and damage tolerance airworthiness standards of 14 CFR (Code of Federal Regulations) part 23, at Amendment 23-48, apply to the landing gear for commuter category airplanes. Subsequently, this individual sent a June 4, 1998, letter to the Ayres Loadmaster model LM200 project engineer at the Atlanta Aircraft Certification Office, which conveys his stated concerns.

The answer is no; 14 CFR part 23 requires no fatigue evaluation of landing gear structure, metallic or composite, for airplanes certificated in any category.

Only the rule portion of the Federal Aviation Regulations is published in the CFR. The CFR neither presents the preamble to the final rule nor contains the preamble to the Notice of Proposed Rulemaking (NPRM). In some cases, in order to get the full FAA intent, a review of all of these documents is necessary, especially the preamble to the NPRM.

Amendment 23-48 (61 FR 5130, February 9, 1996), revised the airworthiness standards for fatigue and damage tolerance to their current form. The NPRM that led to the amendment, (Docket No. 27805, Notice No. 94-20 (59 FR 35196, July 8, 1994), *Airworthiness Standards; Airframe Proposals Based on European Joint Aviation Requirements Proposals*), states the FAA's intent regarding damage tolerance for airplanes certified to part 23. The NPRM contains the following information:

"The revision consists of naming those requirements that are included, namely §§ 23.571, 23.572, 23.573 and 23.574. These four sections address pressurized cabin, wing, empennage (tail), and associated structures for metallic airplanes. They also provide standards for damage tolerance and fatigue evaluations of both composite and metallic airplane structures."

These are the only four major airplane assemblies identified in the preamble to the NPRM.

CONCURRENCES
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With this background in mind, the FAA's intent is clear: landing gear structure is not included in the fatigue and damage tolerance requirements of Amendment 23-48. This interpretation is consistent with previous airworthiness standards that appear in Special Federal Aviation Regulation No. 41, Appendix A of part 135, and earlier versions of part 23 (see Attachment 1). Historically, except for the fatigue strength requirement in § 23.627, which encourages good fatigue design practices, the FAA has limited the required small airplane fatigue evaluation to airplane components. Small airplane fatigue requirements began with the pressure cabin in 1957. It added the wing, wing carry-through and attaching structure in 1969; the empennage in 1989; and the composite fuselage and composite control surfaces in 1993. Landing gear does not appear in part 23 as a component requiring fatigue evaluation.

In the June 4 letter, the DER compared parts 23 and 25 since they both address fatigue substantiation. He noted the identical verbiage of these two parts, that they apply to "each part of the structure that could contribute to a catastrophic failure." The DER correctly noted that part 23 does not define the specific systems that cause catastrophic failure and that part 25 provides a list of examples, which includes the landing gear.

The FAA recognizes the similarity of wording in parts 23 and 25, but notes different consequence of landing gear failures for small airplanes than for large transport airliners. A current FAA analysis of recent accident and incident reports for commuter service and commuter category airplane landing gear failures continues to justify the exclusion of landing gear structure from a required fatigue substantiation. For a 5¼ year search, there are no deaths or injuries caused by fatigue of landing gear structures (see Attachment 2).

Part 23 requires no fatigue substantiation of the landing gear partly because the consequence of landing gear failure on small airplanes has not been significant enough to justify the costs. In the economic analysis for Amendment 23-45, the FAA attributed no additional costs of compliance for the damage tolerance and fatigue evaluation of structure (§ 23.573) when it was added to part 23. Similarly, in Amendment 23-48, the FAA imposed no additional compliance costs to a designer or manufacturer of metallic commuter category airplanes. The FAA added no new airplane components, like landing gear, to the required fatigue evaluation airworthiness standards during these rule changes.

In summary, 14 CFR part 23 contains no comprehensive fatigue evaluation airworthiness standards for landing gear other than the design detail requirements for fatigue strength that appear in § 23.627. Although not required by part 23, a fatigue substantiation of landing gear is common practice within the industry. To promote safety, the FAA encourages this practice.

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Attachments

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History of Part 23 Fatigue Requirements

Attachment 1

Prior to 1956, the only fatigue requirements for small airplanes appeared in the Civil Air Regulations (CAR), § 3.307. During the recodification from the CAR to the Federal Aviation Regulation, it became the fatigue strength requirement (§ 23.627); it **requires the airplane designer to choose design details that avoid stress concentrations**. This airworthiness standard applies to all structural design details of the whole airplane.

Amendment 3-2 added specific comprehensive fatigue requirements to CAR 3, effective August 12, 1957. It **added the pressurized fuselage structure** for a fatigue assessment (see § 3.270).

On September 14, 1969, Amendment 23-7 to part 23 **added the wing, wing carry-through and attaching structure** to fatigue requirements for small airplanes. At that time, these regulations only addressed normal, utility, and acrobatic category airplanes.

Special Federal Aviation Regulation No. 41 (SFAR 41) became effective on September 17, 1979. It required a fatigue substantiation of “those parts of the wing, wing carry-through, vertical fin, horizontal stabilizer, and attaching structure whose failure would be catastrophic ...”

The FAA **added empennage** to the part 23 fatigue requirements at Amendment 23-38 on October 26, 1989. Commuter category airplanes were new to part 23 (only two amendments previous to this revision).

Amendment 23-45 text **expanded the fatigue assessment of wing structure to include canards, tandem wings, and winglets/tip fins**. This amendment became effective on September 7, 1993. Also, this same amendment **added damage tolerance and fatigue evaluation of composite structure** to the airworthiness standards for small airplanes. *For composite structures, now the damage tolerance evaluation encompasses the wing (including canards, tandem wings, and winglets), the empennage, their carry-through and attaching structures, the movable control surfaces and their attaching structures, the fuselage, and the pressure cabin.*

Then, on March 11, 1996, the FAA **added damage tolerance to the fatigue evaluation for metallic structure commuter category airplanes**. This was known as Amendment 23-48. The rule appears as § 23.574 in the part 23 airworthiness standards. The rule actually reads as follows:

“An evaluation of the strength, detail design, and fabrication must show that catastrophic failure due to fatigue, corrosion, defects, or damage will be avoided throughout the operational life of the airplane. This evaluation must be conducted in accordance with the provisions of § 23.573 . . . for each part of the structure that could contribute to a catastrophic failure.”

Lastly, Appendix A of part 135 — the rule that addresses operating requirements for commuter and on-demand aircraft operations — contains airworthiness standards for airplanes capable of carrying ten or more passengers. That Appendix imposes a fatigue assessment of “those parts of the wing, wing carry-through and attaching structure whose failure would be catastrophic ...”

Accident and Incident Reports (1/1/93 through 5/30/98)

Attachment 2

Make & Model		# of Landing Gear reports	# of deaths	# of injuries
Beech	99 (all models)	11	0	0
	B 300	0	0	0
	B 300LW	0	0	0
	1900C	24	0	10 ¹
	1900D	17	0	0
	Starship 2000	1	0	0
BAe	3101	9	0	0
	3201	12	0	0
Cessna	206	18	3 ²	1 ³
	207	5	0	0
	208	1	0	0
	402	16	0	0
	402C	22	0	0
DeHavilland	DHC-6	0	0	0
Dornier	228-100, -200	0	0	0
	228-101, -201		0	0
	228-202	0	0	0
	228-212	0	0	0
Embrair	EMB 110	0	0	0
	EMB 120	13	0	1 ⁴
Fairchild	SA 226	12	0	0
	SA 227	17	0	0
Pilatus	PBN BN-2 Mk III	0	0	0
Piper	PA 23	48	0	0
	PA 31	38	0	8 ⁵

¹ Unexplained injuries following manual landing gear extension and landing.

² Floatplane landing gear; water landing; float skin separated (improper maintenance).

³ See footnote # 2.

⁴ Normal braking failed while taxiing; use emergency brake.

⁵ Takeoff too slow to climb out of ground effect.

Short Bro.	SD3-30	4	0	0
	SD3-60	5	0	0
	SD3-Sherpa	0	0	0
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	TOTALS	274	3	20

None of the deaths or injuries are related to landing gear fatigue.